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included in comparisons, but the companion to L was not even suspected.

I should have estimated magnitudes in all cases higher than Burnham's numbers, but my experience is not yet sufficient to warrant my committing myself to numerical estimates, and unfortunately our wedge photometer has only just been received, so that no measures have been made, though observations of faint stars chosen by the American Committee for stellar magnitude standards lead me to the view I have expressed about estimating magnitudes.

Observatory, Cambridge:
1892 *May* 13.

On a Diagram useful as a Guide in adjusting a Diffraction-Grating Spectroscope. By H. F. Newall, M.A.

The diagram which this note describes is intended to give at a glance the interpretation of the well-known relation

$$m\,\lambda = d\,(\sin\phi + \sin i)$$

which connects the angles of incidence i and of emergence ϕ of a beam of light of wavelength λ in a spectrum of order m produced by a plane diffraction grating, on which lines are ruled with an interval d between them.

The diagram has been constructed for a grating ruled with 14438 lines to the inch, which gives $d = 17592 \times 10^{-7}$ mm.

Two rectangular axes are taken; the length of incidence is represented by the length of a line measured off along the horizontal axis, which shall be called the axis of incidence; the angle of emergence of any diffracted beam is represented by a line measured off along the vertical axis, or axis of diffraction.

To explain the construction of the diagram, I describe the plotting of one curve. The following table shows the angle of emergence for the C line in the spectrum of the third order for varying angles of incidence. In above equation, $m = 3$, $\lambda = 656{\cdot}18 \times 10^{-6}$ mm.

Incidence.	Emergence.	Incidence.	Emergence.
°	° ′	°	° ′
0	—	50	20 39
10	70 55	60	14 38
20	50 57	70	10 19
30	38 13	80	7 42
40	28 25	90	6 49

These values are plotted on the diagram, and the points so obtained are joined by a continuous curve.

Proceeding similarly for other orders of spectra, we cover

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the diagram with curves for the C line. Again *mutatis mutandis* for the H line.

For application to the case of any particular spectroscope, we must consider what may be called the constraints of the spectroscope.

I. If the telescope and collimator are relatively fixed at an angle θ, whilst the grating is free to turn so as to make any incidence possible, then the emergence must satisfy the constraining condition $i \pm \phi = \theta$, and the sequence of phenomena in the telescope, as the grating is turned from a position in which incidence is perpendicular to a position in which incidence is grazing, is represented by the sequence of curves cut by a straight line $i \pm \phi = \theta$ (const.).

For instance, if telescope and collimator are inclined at an angle of 30°, we get the sequences along the lines AB and CD, which cut the axes at points corresponding to 30°, and are inclined at 45° to the axes.

II. If the grating and collimator be relatively fixed, so that the incidence is constant whilst the telescope is free to turn so as to catch a beam issuing with any angle of emergence, the sequence of phenomena in the telescope as it turns is shown by the sequence of curves cut by the straight line $i =$ const., which is a line parallel to the axis of diffraction.

III. If the grating and telescope are relatively fixed, so that the angle of emergence is constant, whilst the angle of incidence may be varied by turning the telescope and grating with respect to the collimated beam, then the sequence of phenomena in the telescope is shown on the line $\phi =$ const., a straight line parallel to the axis of incidences.

When the angles of incidence and emergence are such that the width of the beam is diminished by the action of the grating, then the action of the grating is magnifying, quite apart from the magnifications produced by the use of the telescope. I have plotted on the diagram lines of equal magnification for the arbitrary values 3, 2, 1, $\frac{1}{2}$, $\frac{1}{3}$ of the magnification.

The dispersion may be shown by another curve. I have plotted a curve on the diagram to show the relative dispersion in any spectrum, taking as unity the dispersion in that spectrum when it is observed when the telescope is perpendicular to the grating. In passing from a given order of spectrum to another, account must be taken of the change of order in considering the dispersion.

In much astronomical work the needless loss of light is to be avoided. It is of assistance, therefore, to have a curve showing what length of the grating is filled by a collimator of given aperture at varying incidences. I have plotted such a curve for a collimator of aperture 1·5 inches, and for a grating whose ruled

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surface is $3\frac{1}{8}$ inches long. A second curve shows what length of grating will fill the telescope of aperture 1·5 inches at varying angles of emergence of the diffracted beam.

Consider a case in which it is desired to observe the C line in the spectrum of third order with a spectroscope in which the telescope and collimator are fixed at an angle of 30°. On the diagram it is seen that two positions of the grating are possible —one in which the action of the grating is magnifying, the other where it is the reverse. Which of these positions is best will depend on the object of the observation.

In this connection it may be remarked that the actual brightness of the spectra produced by a given grating probably depends on conditions which cannot be completely controlled, in the shape of the groove cut by the ruling diamond. The brightness of a given spectrum for given values of incidence and emergence is in general different according to which end of the ruled lines is uppermost (the lines being considered vertical). Hence, if particular values of incidence and emergence are desirable, the brightness may be in general increased or diminished by turning the grating "head for tail."

I am induced to publish the diagram, because I have found it of very great assistance in designing a spectroscope, and also in actual use of a grating spectroscope. So far as I am aware, no such diagram is accessible, though the simplicity of its construction would lead one to expect it has been long in use in laboratories.

Comet Swift, March 1892. By H. C. Russell, B.A., F.R.S.

We received the cablegram of the discovery of this comet on March 9, but owing to clouds could not see it until the morning of the 11th, when some micrometer measures were obtained, also a photograph, showing five equidistant rays, the outside ones enclosing an angle of 25°. There was not much difference in their length, the longest one measuring 35 minutes of arc. The exposure given was 1 hour 50 minutes, but owing to the frequent passage of thin cloud and the bright moonlight the picture of the rays is very faint. Cloudy weather again intervened, and we did not see the comet until the morning of the 22nd, when the air was much clearer, but there was a good deal of passing cloud; during an exposure of 2 hours 23 minutes clouds covered the comet for 28 minutes; the $11\frac{1}{2}$-inch equatoreal showed no tail except a slight hazy extension, and not a sign of any ray. The photograph shows no less than eight rays, two of which extend to the edge of the photograph and may have been even longer; the recorded length is, however, 1° 10′. On the side of these two long rays three new rays appear, and one of